What determines misallocation in innovation? A study of regional innovation in China

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A R T I C L E   I N F O

A B S T R A C T

This paper sounds an alarm about disparate efficiencies among China's regions in the allocation of innovation inputs. A theoretical measure of misallocation is adopted to gauge the distortions that exacerbate the inefficiency of resource allocations across geographic innovation units; these units' usage of innovative inputs reveals the level of misallocations prevalent within the Chinese economy. The measure of innovation misallocation is computed by utilizing a micro dataset based on information from the China Statistical Yearbook for Science and Technology (CSYST) from 1999 to 2012. In addition, this paper probes the factors that co-move with China's innovation resource misallocations. We find that, although an advanced financial market is beneficial to innovation efficiency in China, both the government's extensive development of transportation infrastructure and the preferential treatment given to state-owned enterprises (SOEs) and foreign-invested enterprises (FIEs) negatively correlate with innovation efficiency. We conclude that emerging economies that are experiencing R&D input expansion, such as China, should be cautious in ensuring efficient resource allocations.

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1. Introduction

History has documented that different nations follow very different development paths. Whereas some countries have successfully evolved through many stages of growth—from traditional economies to modernized economies—other countries have halted their transformations or even collapsed after enjoying some early development success. In an influential work, Acemoglu and Robinson (2012) conclude that an economy dominated by extraction, in which only a few privileged people can access limited production resources, will cause a nation's downfall. Specifically, failing nations often suffer from prevalent resource misallocation and stop embracing innovations that are critical to continuous development.[1]

Resource misallocation has been identified as a major hurdle to the delivery of high productivity in all aspects of production, as surveyed by Syverson (2011).[2] Because innovation is essential to sustaining long-run growth, timely awareness of disparate efficiencies in allocating resources across innovation units should be a priority for an economy (such as China) that is interested in modernization. Interestingly, whereas many aspects of growth have been extensively studied, the eco-

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[1] As noted by Acemoglu and Robinson (2012), one main reason that extractive economies may not be interested in innovations arises out of their elites' concerns about creative destruction that may lead to their loss of power.

[2] For example, the relatively early work by Peek and Rosengren (2005) demonstrates that in Japan, such misallocation is severe. Greenwood and Krusell (2007) develop a model and argue that the level of financial development affects resource allocation across firms within an industry.

nomic literature has almost entirely neglected the misallocation of innovation resources. An exception is a recent paper by Uras and Wang (2016), which emphasizes the importance of technique misallocation on industry-level total factor productivity (TFP). In their model, technique misallocations arise from heterogeneous technique capabilities, and these diverse capabilities could be thought of as a consequence of differing investments in process innovations. We further their study by investigating the determinants of misallocation in innovation activities.[3] In particular, we study cross-region misallocations in the use of innovative inputs within China. As conceptually noted by Hsieh and Klenow (2009), relative to an ideal environment in which competitive input markets ensure equalization (among regions) of the marginal contribution of the last unit of innovation inputs, differences in regional distortion levels result in misallocations and lower aggregate performance.[4] Some of these distortions reflect intentional government policies, such as capital subsidies or preferential tax treatments that favor particular innovation units. Other distortions reflect an exclusive seller's power, which can lead to gigantic monopoly rents for their innovation outputs.

In this paper, building upon Hsieh and Klenow's (2009) insights into misallocation, we calculate a theory-based measure of innovation efficiency in China. This measure of innovation efficiency will assume a larger value if the dispersion of revenue productivity (TFPR), which is a function of the regional innovation input and output distortions, is smaller across regions. In other words, when the extent of distortion is similar across regions, our measure of innovation efficiency will be higher.[5] During our computation of the innovation efficiency measure, we have also derived the TFPR for each region in each year.[6] Because a region's TFPR can be viewed as an inverse measure of that region's distortions, in the second step of our analysis, we proceed by identifying the potential sources of regional distortions.

We collect a new micro dataset with information on regional innovation inputs and outputs in China. We obtained these data from the China National Statistical Bureau's China Statistical Yearbook for Science and Technology (CSYST) from 1998 to 2013. Our analysis covered thirty provincial-level regions in China between 1999 and 2012.[7] Following the existing literature, we use the number of patent applications under the invention and utility model categories as the innovation output and assume that the utilization of R&D capital inventories and personnel are the main innovation inputs.

Our measure of innovation efficiency increases substantially during the sample period: it starts from 0.5023 in 1999 and rises to 0.8016 in 2012.[8] This increase indicates substantial convergence in the extent of the distortions across the regions in China. However, our result also suggests that, whereas innovation efficiency constantly improved between 1999 and 2009, beginning in 2010, there was a sign of deterioration in innovation efficiency: the efficiency measure modestly decreased for the three consecutive years between 2010 and 2012.

The second part of our empirical study further extends the literature by investigating the factors that affect innovation efficiency. A variety of setups have been adopted to robustly establish that an advanced financial market is beneficial to regional innovation efficiency in China. However, extensive development of a regional transportation infrastructure is negatively correlated with innovation efficiency. We argue that this pattern occurs because a sophisticated regional transportation infrastructure may not increase the efficient allocation of innovation resources; furthermore, devoting excessive government resources to the transportation infrastructure may have a distortive effect on public and private innovation investments. In addition, we find that preferential policy treatments issued by governments will be biased toward the misallocation of innovation inputs. More specifically, we find that higher shares of state-owned enterprises (hereafter, SOEs) and foreign invested enterprises (hereafter, FIEs) in regional industry output hurt innovation efficiency. Because SOEs and FIEs often have better access to credit or enjoy more tax deductions, preferential policies may have distortive effects on total innovation investment if SOEs and FIEs do not consider innovation activities their priority. SOEs and FIEs' hindering effect on innovation efficiency is first proposed by this paper. However, we are not alone in indicating that low productivities are associated with SOEs and sometimes with FIEs. SOEs' mediocre performance is well known (e.g., Brandt et al., 2012); recent studies also document the unexceptional performance of Chinese exporters, many of whom are FIEs (Dai et al., 2012; Lu, 2010; Yu, 2015).

Studies on resource misallocation have become a focal point in the growth literature since the seminal work by Banerjee and Duflo (2005); those studies find that the large dispersion in the marginal product of capital among Indian firms results

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[3] While Uras and Wang (2016) emphasize the role played by *process* innovation, our analysis studies misallocation in innovation activities as a whole and does not explicitly differentiate between process and product innovations.

[4] Hsieh and Klenow (2009) focus on resource misallocations in India and China and attribute those countries' losses in production efficiency primarily to differences in their government policies. These distortions influence the differences in TFP across industries in different countries.

[5] According to Bartelsman et al. (2013), the improvement in allocative efficiency is associated with the process whereby limited production inputs are reallocated from less-productive to more-productive units within an economy.

[6] The gauge of innovation productivity begins with a measurement of the idiosyncratic input distortions at the regional level. Thus, this first step requires intensive data support at the regional level, which we describe below.

[7] In our calculation, we allowed a one-year lag from the usage of innovation inputs to producing outputs. In addition, because the CSYST yearbook provides data for the previous year, our actual period of analysis is from 1999 to 2012. Furthermore, we do not include Tibet in our analysis because of a large amount of data are missing for that region.

[8] This measure denotes the ratio of the actual and "efficient" production levels of innovation, where "efficient production" is defined as the output level that is obtained when there are no misallocations of resources across the regions within China. For example, a value of 0.5 means that innovation production would have doubled (1/0.5=2) had the misallocations been eliminated.